NUCLEAR TECHNOLOGY

Research in Nuclear Technology includes both nuclear weapons and effects and counterproliferation. Nuclear weapons and effects research areas include neutral particle transport methods, non-ideal blast modeling, radioactive source term from weapons, fallout transport and dose estimates, x-ray simulation modeling, radiation effects in electronics, and radiation hardening. Counterproliferation research areas include counterproliferation analysis, NBC sensors and spectroscopy, nuclear fuels chemistry, and nuclear radiation imaging.

A variety of research efforts are currently underway in the area of nuclear weapons and effects, and include the development of new, nonlinear radiation transport algorithms and their incorporation into computer codes to provide robust performance on computationally challenging problems. Investigations have been also conducted into the predictive capabilities of the Defense Threat Reduction Agency's Hazard Prediction and Assessment Capability code (HPAC). The radioactive source terms and ultimate dose to individuals as predicted by HPAC have been compared to theoretical predictions and to historical results. Additional research has been conducted into the rise and growth of nuclear clouds. The prompt and residual effects of nuclear weapons on materials is also being investigated and includes non-ideal blast effects, thermal effects on layered structures, radiation effects in electronics, and determination of radiation hardness.

Nuclear weapons and effects experimental facilities are available for radiation detection, characterization of material changes, simulation of radiation environments, and analysis of the effects of the nuclear weapons environment. High-end personal computers are used extensively to take high-speed measurements as well as to model the environments of interest and changes to material characteristics in the weapons environment.

Research in chemical, biological and nuclear spectroscopy is used to characterize signatures for counter-proliferation target identification. Photo-thermal spectroscopy and IR pattern recognition have been applied to distinguish chemical agents from structurally similar pesticides. Potential for identifying microorganisms by IR volatile signatures has been demonstrated. Different spectroscopic signatures of uranium fuels have also been measured. Multiplexed Compton scatter imaging has been developed for one-sided tomography and the method is being extended to image structures surrounding gamma-emitting nuclear materials. Analysis of proliferant country fuel cycle capabilities has been conducted for both plutonium and highly enriched uranium.

State-of-the-art departmental counterproliferation experimental facilities range from nuclear radiation measurement laboratories using high-resolution detectors and imaging arrays to molecular spectroscopy laboratories having infrared, Raman, and photoluminescence spectroscopies. Chemistry and biology characterization labs are

also available. Modeling is done using a network of workstations. For large computational requirements, the world class ASC Major Shared Resource Center provides access to state-of-the-art parallel processing capabilities and visualization tools.

FACULTY:

Bridgman, Charles J.
Professor Emeritus of Nuclear Engineering
B.S. United States Naval Academy, 1952; M.S., North Carolina State University, 1958; Ph.D., North Carolina State University, 1963: nuclear weapon effects and military nuclear power application; nuclear weapon fallout modeling.

Burggraf, Larry W.
Associate Professor of Engineering Physics
B.A., Olivet Nazarene University, 1968; M.S., Ohio State University, 1971; M.A., University of West Florida, 1977; Ph.D., University of Denver, 1981: detection of trace chemicals and radio-nuclides by optical and nuclear techniques using selective pre-concentration; quantum calculations to model adsorbate interactions with surfaces, especially silica and alumina; and optical spectroscopy of nuclear fuels.

Jodoin, Vincent J.
Assistant Professor of Nuclear Engineering
B.S., Rensselaer Polytechnic Institute, 1985; M.S., Electrical Engineering, California State University, 1988; M.S., Air Force Institute of Technology, 1989; Ph.D., Air Force Institute of Technology, 1994. Nuclear weapon effects and nuclear proliferation modeling.

John, George
Professor Emeritus of Nuclear Engineering
B.S., The Ohio State University, 1948; Ph.D., The Ohio State University, 1952: applications of nuclear radiation and radio-nuclides, including applications of Mossbauer Effect to problems in materials science; analysis of radio-nuclides in the environment; development of nuclear radiation detectors and general techniques for detection of nuclear radiation.

Mathews, Kirk A.
Professor of Nuclear Engineering.
B.S., California Institute of Technology, 1971; M.S., AFIT, 1982; Ph.D., AFIT 1983. Neutral particle (neutron, gamma-ray, x-ray) radiation transport computational methods; weapons effect simulation; radiation spectrum unfolding.

Petrosky, James C.
Assistant Professor of Engineering Physics
B.A., Engineering Physics, Millersville State University, 1984; M.S., Engineering Physics, Rensselaer Polytechnic Institute, 1992; Ph.D., Engineering Physics, Rensselaer Polytechnic Institute, 1995. Radiation effects on semiconductors, reactor physics, and semiconductor device characterization.

SOME RECENT PUBLICATIONS:

"Split-Cell, Exponential Characteristic Transport Method for Unstructured Tetrahedral Meshes", Nuclear Science and Engineering, Sept 2001, Charles R. Brennan, Rodney L. Miller, and Kirk A. Mathews.

"Nonnegative Anisotropic Group Cross Sections: A Hybrid Monte Carlo / Discrete Elements / Discrete Ordinates Approach", Nuclear Science and Engineering, Accepted, J. Mark DelGrande and Kirk A. Mathews.

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"PS: Nuclear Waste Terms Redefined," Letter to the Editor, *Physics Today,* p. 88-90, January, 1998, John, George.

"XANES and Mossbauer Study of PFPAE Based Additives," ACS Spring-97 meeting, San Francisco, CA, J.N. Cutler, J.H. Sanders, and G. John.

"A Study of Reactions Between Fe-Containing Compounds and Perfluoropolyalkylethers Using Mossbauer Spectroscopy," ICMCTF '97, Spring Meeting, San Diego, CA, J.H. Sanders, J.N. Cutler, J.S. Zabinski, and G. John.

“Exponential Characteristic Radiation Transport Method for Unstructured Grids of Triangular Cells”, Nuclear Science and Engineering, Vol 126, No. 3, pp. 264-281 (1997), Kirk A. Mathews and Charles R. Brennan.

"Exponential Characteristic Nonlinear Radiation Transport Method for Unstructured Grids of Triangular Cells", Nucl. Sci. Eng., 126 (3), 264-281, July 1997, K.A. Mathews and C.R. Brennan.

“Modeling and Design of Portable Compton Gamma-Ray Cameras”, 1996 IEEE Nucl. Sci. Symp. Conf. Record, 793-797, March 1997, B.L. Evans and J.B. Martin.

"Detecting Alpha Radiation by Scintillation in Porous Materials", IEEE Trans. on Nucl. Sci., 44 (5), 1997, M.E. Keillor , and L.W. Burggraf.

"Corrosion of iron by a perfluoropolyalkylether identified by Mossbauer spectroscopy," Applied Surface Science, Volume 93, No. 4, May 9, 1996, John, G., J. S. Zabinski, and V. K. Gupta.

"Split-Cell Discrete Ordinates Transport on an Unstructured Grid of Triangular Cells", Transport Theory Stat. Phys., 25 (7), 833-867, November 1996, D.J. Miller, K.A. Mathews, and C.R. Brennan.

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"Influence of Radionuclide Adsorption on Detection Efficiency and Energy Resolution for Flow-Cell Radiation Detectors", IEEE Trans. on Nucl. Sci., 43, 1310-1315, 1996, T.A. DeVol, M.E. Keillor , and L.W. Burggraf.